cases, however, the loss of speech brought with it the loss of musical expression, though it was definitely ascertained that at least two of the five were musically inclined. Whether these differences depend on individual education, upon different locations of the affected mental centres, or upon the intensity of the affection, remains to be determined.

ELECTRICAL SCIENCE.

Electric Conductors for Alternating Currents.

ONE of the most practical and useful papers read before the last meeting of the British Association was one by Sir William Thomson, in which he calculated the distribution of a rapidly varying electric current in a conductor.

It is well known that an electric current which has reached a steady condition in a wire is uniformly distributed through its section, and the resistance of the wire varies inversely as the area. But with rapidly varying currents the case is different, and the difference may be understood from an analogy to liquid motion, due to Mr. Heaviside. In the first place, Professor Poynting has shown that the electrical energy which appears in a wire carrying a current is not conveyed directly through the wire from the dynamo or battery supplying it, but it is first conveyed to the medium surrounding the circuit, and then enters the wire at every point from the medium. According to Mr. Heaviside, the state of the case may be partially represented by a hollow tube in a tank of water. If we move the tube slowly in one direction, and if the tube be long in proportion to its diameter, then in a short time all of the particles of water in the tube will be moving with it, at the same velocity. This represents a steady current; and it partly illustrates Professor Poynting's idea, for the motion of the water is due to the friction of the tube at every point of the boundary, not to a pressure along the tube such as would be produced by a piston in it.

If, instead of giving a steady motion in one direction, we move the tube backward and forward rapidly, we will have the outer layer of water moving nearly as fast as the tube, the velocity decreasing as we proceed inward; and, finally, if we make the oscillations short enough and rapid enough, the inner layers will not move at all, only the particles near the outside taking part in the motion.

Now, this is exactly what happens in the case of an electric current which changes very rapidly. If the change is rapid enough, the current — corresponding to the velocity of the particles of water — will be mainly near the outer surface of the wire, and it might happen that there is no current at all at the axis. The effect of this is to increase the apparent resistance of the conductor, causing a greater loss from heating, and a greater fall of potential, than ordinary calculation would give.

Now, although these facts have been pretty well known since Maxwell's treatise on electricity and magnetism was published, yet very few people suspected that they would have any practical bearing on alternating systems of electrical distribution. Sir William Thomson, however, in calculating out some numerical examples, obtains results which show that in the alternating system as ordinarily used a considerable portion of the inside of the conductors does not carry any current at all, and is useless. For example: with the period of alternation used by the Westinghouse Company in the United States, in the neighborhood of eight thousand a minute, the current does not penetrate so much as one-eighth of an inch into the wire. The size of conductor used for distributing current for even a moderate number of lamps — say, a thousand lamps at a mean distance of a mile — is much beyond this limit of semi-diameter, in the case cited being more than half an inch in diameter. The result is a much greater loss by heating than is usually calculated, and a fall of potential that in some cases interferes with the brightness of the lamps. In order to make these effects a minimum, it would be necessary to use for conductors either thin, hollow tubes, or thin, flat strips of metal, and especially is this the case when a large number of lamps are to be supplied. The expense of the tubes would in all probability make their use impracticable; so that in future we may expect to see any extended alternating-current distribution either with copper strips as conductors, or with a number of comparatively small wires. It should be pointed out as an illustration of the value of a sound mathematical training in applied electricity, that the best form of conductor for any particular case of distribution, whether strips, a single wire, or a number of wires, can be calculated from obtainable data as to prices. It is the experience of the writer, however, that few electric plants are installed in a way to secure the greatest economy, and much money is wasted needlessly from neglecting to make the necessary calculations.

THE SUN-LAMP. — One of the most attractive of high-power electric lamps is that known in France, where it was invented, as the '*lampe soleil*.' It consists of a wedge of some refractory material, marble preferably, held between two carbon rods that are inclined to one another. This is set in a cavity in a marble block held in an iron frame. A very simple lamp of this kind can be made by boring a couple of holes in a block of marble so they are slightly inclined and approach within about a quarter of an inch at the bottom, and putting in two carbon rods. If this be supplied with an alternating current to form an arc between the carbons, the marble will be heated, and will give off a brilliant, mellow light of a golden tinge, very different from the piercing but rather disagreeable light of the ordinary arc-lamp. A very high candle-power can be obtained from it, and it is absolutely steady. The objections to its use arose from the facts that it was not certain to start up automatically when the current was turned on, and it required alternating currents instead of direct. This was some years ago, before alternating currents had been largely introduced. From the fact that a larger surface has to be heated than in the ordinary arc-lamp, and the surrounding material conducts away a considerable amount of heat, the lamp is not so economical as are arc-lamps. In the last few years alternating-current distribution has been developed, and now an English syndicate is being formed to introduce a modified sun-lamp, in which many of the objections of the old form have been removed. The lighting is now automatic and certain, and the lamp can be used either with continuous or alternating current generators. For lighting halls, galleries, etc., and in general for interior illumination, this modified lamp should have an extensive field.

THE ELECTRIC LIGHT VS. GAS IN FRANCE. — Messrs. Brun & Co., owners of a silk-manufactory at St. Clamond, give some particulars, in *Annales Télégraphiques*, as to the comparative cost of gas and electric lights, obtained from two years' experience in their works. The original lighting of the factory was by 540 gas-jets, consuming 20,000 francs' worth of gas annually. These were replaced by 600 incandescent lamps, — one-half Edison, the rest Swan, — the average life being 1,200 hours. The current is supplied by an Edison dynamo of 450 ampères and 100 volts. It has worked for 18 months at an average of 15 hours per day. Part of the factory works night and day, and some of the lamps work 3,600 hours a year, while others are only used for 600 hours. The following are the expenses: —

Cost of 90-horse-power engine, with fittings	32,000 francs.
Dynamo, conductors, lamps, etc	23,000 "
Total	55,000 francs.

The yearly cost is, —

10 per cent sinking fund	5,500 francs.
5 " " interest	2,750 "
Increase in coal-consumption	1,200 "
" " oil, etc	250 "
Renewal, 600 lamps	2,700 "
Total	12,400 francs.

The saving is 7,600 francs per annum. The item of labor is not included, as the force of mechanics was not increased on putting in the installation.

BOOK-REVIEWS.

The Land beyond the Forest. By E. GERARD. New York, Harper. 12°.

MRS. GERARD has collected her observations during a two-years' life in Transylvania in the present attractive volume, and greatly enhanced the value of her descriptions by adding to her own experiences information from other sources, which became